

Review ESSD-2018-13, VHR satellite imagery

Earth sciences researchers, at least those that publish wide ranges of data in ESSD, use imagery from Google Earth rarely (see below) and from Microsoft Bing almost never. This manuscript, which counts availability of Google Earth and Microsoft Bing scenes at various terrestrial locations of our planet, has minimal utility and relevance for ESSD readers. Separate from irrelevance, it fails substantially in the quality of its presentation.

Of ESSD data sets published to date, 12 used and cited Landsat imagery. One has already published a data set using ESA Sentinel-2 images. Six others presented .kml files to allow readers to browse data locations using Google Earth - a nice convenience used by many members and institutions among the data sharing community but a false positive when one does a word search for 'Google Earth'. Only one ESSD data set over 10 years actually used scenes from Google Earth, in their case to estimate water colour in un-sampled remote branches of Amazonian rivers (naming, by the way, Landsat as the original source). Those authors issued this clear explicit qualification: "It should be noted that both methods are qualitative and subject to error" (<https://doi.org/10.5194/essd-8-651-2016>). Readers can easily confirm far less than 1% usage of Google Earth scenes in ESSD data products (roughly 300 published in ten years) and a ratio of at least 10 to 1 of Landsat vs Google Earth. No ESSD papers mention Microsoft Bing. Note that these data providers and data users prefer the access and reliability of publicly-available data from USGS or ESA/Copernicus over the higher spatial resolutions (by definitions adopted by these authors, 5 metre vs 15 metre) offered by SPOT or commercial sources such as DigitalGlobe.

In Supplement Figure 2, showing data extracted from SCOPUS (why did these authors not use Web of Science / CLARIVATE instead, for much broader topic coverage?), the authors expect readers to accept that over more than 10 years (2005 to 2016) 1500 (26% of 5756 total publications) papers in the general field of Earth Sciences (probably we can ignore planetary sciences for purposes of assessing utility of earth images) and perhaps an additional 900 papers (16%) in a field called Environmental Sciences mentioned 'Google Earth' or 'Bing Imagery'. Out of 100s of thousands of papers published during those years, roughly 1000 (because the authors give us no breakdown, we assume half for Google Earth and half for Microsoft Bing) mentioned Google Earth? Far fewer - 96 from Figure S5 - mentioned Google Earth in conjunction with remote sensing. Subtracting those papers that referenced Google Earth in terms of a .kml file (as the ESSD experience suggests happens frequently), and a few others that used Google Earth scenes with explicit qualifications (again referencing the ESSD experience), something like 50 papers - 5 per year over 10 years - mentioned Google Earth in conjunction with remote sensing? From their own data, these authors demonstrate the minuscule impact of Google Earth scenes on earth system research (and their search does not distinguish lower resolution from higher resolution images)!

Google Earth and Microsoft Bing use multiple sources and elaborate processes to acquire, assemble and display their maps. Any individual scene thus carries a complicated, evolving and largely proprietary provenance, not openly documented and generally not available to researchers. Any Google Earth or Microsoft Bing scenes that display features of 1 to 5 metres in extent must have supplemented Landsat imagery with higher-resolution sources (listed above), but in a manner hidden to users. Although convenient, useful and fun (!) for a wide variety of personal navigation and information purposes, earth and environmental science researchers strongly prefer original aerial or satellite images because of their far-superior metadata, documentation, veracity, etc. If these authors had done a similar search on 'Landsat' or 'SPOT' or even 'Sentinel-2' (not launched until 2015) using SCOPUS, this reviewer predicts they would have generated tens of thousands of hits in a general search and hundreds to thousands if they looked again for remote sensing. Landsat and even Sentinel-2 dominate the image 'market' for research.

This reviewer finds a most-recent Google Earth image of my present location dated July 2014, with both Landsat and Copernicus (e.g. ESA Sentinel) attributed as sources (Sentinel for a 2014 image???), carrying a Google 2018 copyright notice. I estimate - because I can not determine from reliable metadata - a spatial resolution for urban features of 0.5 to 1 metre in 2014 which degrades rapidly and substantially (and occasionally loses registration) in prior images from 2011, 2009, 2005, etc. From USGS EarthExplorer I can relatively easily find mid-day Landsat 8 images

of my location, at resolutions of 30 (vis) or 15 (panchromatic) metres. Applying the most stringent cloud removal filters (<10% for both scene and image) I can download 50 strikingly clear images covering all seasons from late 2013 up to last week, sizes 10MB to 1GB depending on my choices of format and on my network speeds. I could access another 50 images with a slightly different but overlapping view angle. For every image I could document and share: time, orbit, acquisition parameters, exact file name and format, etc. If I want to monitor and describe annual or seasonal patterns of snow cover, surface hydrology (e.g. reservoir levels), vegetation changes, agricultural choices and practices, wildfire burn areas, urban development, etc., I will rely on these Landsat images in preference to Google Earth images of variable temporal availability and uncertain provenance. If I considered cloud distribution and coverage as valid features of my research (to validate ground-based radiation measurements, for example), I could choose among hundreds of additional images over the same time period. For most monitoring purposes, researchers need reliable time coverage while tending to avoid the huge file sizes associated with 0.5 metre spatial images if available. The authors make much of their VHR definition, but for most sites and most usages that highest resolution applies only to most-recent scenes and - due to large files sizes already mentioned - proves impractical for compilation and use on personal computers? Even the World Urban Data Access Portal Tool (<http://www.wudapt.org>), trying to develop useful inter-comparable time series of climate-relevant land use changes for urban settings around the world, starts from Landsat data.

Apologies for long-ish discussion of utility of Google Earth images. In general, not relevant to ESSD users.

Direct comments on the manuscript, overall not up to standards expected for most journals.

Why the distinct asymmetry in corporate recognition? A reader sees 'Google' constantly but 'Microsoft' almost never?

The data table downloads easily and opens in Excel, Google spreadsheet, Numbers, etc. Authors used a 1 degree search algorithm. Global 1 degree is 360 by 180 but assume no data at latitudes poleward of 80N and 60S so 50,400 possible data points, assume 30% land, gives 15,120. Data table has 20 header rows followed by 15368 rows of lon lat data. Assuming many interior data voids (northern Canada, Siberia, Greenland) combined with substantial overlap of Google Earth and Microsoft Bing in data rich regions, 15,000 rows of data seems about right? But header (row 19) lists 59,168 data points. At each of 15,000 lon lat points, Google Earth presence absence, Microsoft Bing presence absence, and date of most recent Google Earth scene, gives about 60,000 values?

Too many of these types of punctuation errors: "Bing Maps(Fritz et al.,." Occurs due to intersection errors between reference software and word processor. Authors should have searched and fixed these beforehand.

Page 2, line 5: LANDSAT operates jointly by NASA and USGS. Most researchers interact with USGS because they manage data distribution. Present fuss about charging again for Landsat images - a spectacularly bad idea possibly fatal for the use of Landsat products in earth system research - centres on US Dept of Interior and USGS.

Page 2, line 6: "see e.g.(Microsoft, 2017)". Should instead read as '(see e.g. Microsoft, 2017)'. This error occurs in several places; authors should have made effort to search and correct.

Page 2 line 7: "still covered by Landsat resolution imagery, i.e. 15 m when pan-sharpened." Because Landsat resolution has evolved both in sensor resolution and data availability, not clear to readers which Landsat resolution the authors reference here? Same text and same problem on Page 17 line 15. Most recent Landsat 8 visible at 30 metres or panchromatic at 15 metres?

Page 2 line 21: the demise of the Google Earth API/plugin occurred earlier for some browsers? Google announced it as early as 2014 or 2015? Do the authors address the issue of tracking image time series from this point forward, e.g. following the loss of the API tool?

Page 6 Figure 3. Potentially useful figure but colour scheme detracts? Very hard to distinguish Google only from Bing only, and which most recent. Probably not accessible to colour-blind users. Consider a different colour scheme with much higher contrast? Category Google only also represents Google more recent by default? Likewise for Bing? Very difficult to view and accept the authors' conclusions about Australia, for example, from this plot. This reader estimates perhaps 60% Bing vs 40% Google for Australia, but with Bing predominant in the central outback while Google coverage dominates the agricultural and urban coastal regions? Figure 3 does not seem to support the text sentence about relative lack of imagery in the Amazon basin or in Australia? High latitudes and Sahara/Sahel yes, but not Amazon or Australia? Why the apparent data hole over Afghanistan? Why the abrupt discontinuities at US-Canada, India-China and Brazil-Bolivia borders? Authors have avoided obvious features while discussing minor features in Australia or Indonesia?

Need a systematic approach, to show careful (as opposed to apparently random) analysis by authors and to enhance utility to users. Start by latitude band? Then move to terrestrial biomes to replace ad hoc mention of e.g. 'temperate' or 'deserts' or 'northern high latitudes'. Because the narrative lacks organisation and structure, a reader can't distinguish useful from non-useful. Abundant in one place relates to absence in another.

Page 7 line 1: here we read about relative abundance of imagery for Australia whereas on Page 5 we read about a lack of imagery for Australia? Weakness in either the language or the analysis? All these 'conclusions' could change if authors presented data in an area-conservative map projection?

Page 8,9, Table 1: possibly useful, but here we find, for example, 70% and 100% coverage for Australia (Google vs Bing) and approximately 70% and 90% for the authors' category "Most of South America". Again this apparent mis-match between what a user reads in the text vs what the user finds in the maps or tables? Perhaps the authors need to define their terms for abundant or deficient?

Eastern Europe shows by far the worst coverage (but gets relatively little attention in the text?), presumably because by these definitions Eastern Europe includes high-latitude Siberia? We would learn more from a comparison of coverage by latitude, at least in the northern hemisphere, than from a coverage by geopolitical region?

Page 10, Figure 4, here "parts of Eastern Europe" qualify as "areas with the most imagery available". Authors should adhere to a careful scale of most, many, abundant, few, etc. Too much confusion and apparent discretion.

Apparently, researchers can access relatively abundant imagery for "some of the more populated regions across all the continents" but at the same time will find modest to low correlations of numbers of images with population in the least populated places with "no correlations in the rest of the world". Authors have raised but not resolved a contradiction here: most VHR scenes available for populated areas but at the same time no correlation between scenes and population centres?

Page 12, Table 2: Protected area relevance would make much more sense on an areal basis rather than the presence-absence approach given here? E.g. number of images that provide extensive coverage per area of protected region by geographic region? A large number of images concentrated in a relatively small protected area have less impact than a few images across a large area? If Eastern Europe or eastern US have relatively large numbers of images but relatively small areas of protection, those regions will distort or invalidate this analysis? Overall, with 3 or fewer images per protected area location, this entire topical discussion seems moot?

Page 13, deforestation: This sentence does not make sense: "There is good coverage by Bing Maps in the Amazon and the Congo basin but there is only one image available and the most recent, frequent year found is 4 to 6 years old." One image constitutes "good coverage"? Due to this confusion, the following sentence about contrast results from Google also makes no sense.

Page 14, cropland: Again, this sentence makes little sense: “The results show that the cropland areas in these countries are covered by more than 90% VHR imagery in Google Earth; there are similar findings in Bing Maps except for Nigeria and Indonesia, which still have high coverage.” What means “high” relative to 90%? Very confusing!

Page 15, 16, Table 4: all countries except Mongolia have greater than 90% and 6 (Google) or 8 (Bing) have 100% coverage. Percentage differences come down to presence or absence of 1 image! Too much inference based on too little information content?

Pages 5, 17 and Table 5: comparison with urban areas. Authors have earlier pointed out the absence of correlation of image numbers with population but here users get a sense of positive correlation with urban areas. ?? Most researchers access current population data from CIESIN (Center for International Earth Science Information Network, Gridded Population of the World, Version 4 (GPWv4): <https://doi.org/10.7927/H4PG1PPM>). The so-called JRC layer as cited provides a gridded version of GPWv4 but in a spatial raster format less useful to many users.

Page 17 and 18: discussion. The points raised in discussion about the abundance of VHR imagery and the potential utility of that imagery seem valid, but in too many places apparently inconsistent with earlier text among the results.

Examples -

- a) If the authors mention the northern parts of Columbia or Ecuador, or parts of Indonesia (which confusingly, shows an imagery deficit on page 5 line 16 but an imagery abundance on Page 10 line 3 and Page 14 line 9), then we should also get some discussion of Afghanistan?
- b) This combination of sentences and text does not make sense: “In the rest of the world there is some complementarity between Google Earth and Bing Maps, e.g. there are only Bing Maps present in parts of Canada, the Amazon, former Soviet Union countries and parts of Australia where Google Earth has no coverage. In contrast, Google Earth imagery adds very little additional spatial coverage ...” What “complementarity”?
- c) “the amount of historical imagery is actually quite small” (I agree!) but earlier we read (Page 7) that “North America, Southern Europe, Southern Africa, and Southern and Southeastern Asia have the richest archive of images”. “Rich archive” vs “quite small”? How does a user / reader know how to judge this information? Where should they look for useful imagery?
- d) “availability of VHR imagery in protected areas was surprisingly poor in North America, Eastern Europe and South America, particularly in Google Earth within the latter two regions” but Table 2 shows all regions except Eastern Europe above 50% image presence but in most cases only 3 images per area. Confusing?

The reference list seems very weak. It consists predominantly of reports, AGU abstracts, and self-promotional database or data portal documents. I count only 5 or 6 valid scientific publications using VHR imagery. The authors tend to defeat their case with this clearly-padded list.

If VHR scenes become both more available and more useful, readers will need a much more organised, systematic and compelling guide than the one provided here. At best, it seems premature and not up to the quality expected for ESSD.